

ASSESSMENT OF YIELD LOSSES IN MAIZE FIELD CAUSED BY *OSTRINIA NUBILALIS* HBN. (LEPIDOPTERA : PYRALIDAE) AT FAYOUM GOVERNORATE.

SABRA, I. M., M. M. I. KHEWA AND M. S. I. SHALABY

Plant Protection Research Institute- ARC, Dokki, Giza, Egypt

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Abstract

The yield loss in maize caused by European corn borer (ECB) *Ostrinia nubilalis* was investigated in Fayoum Governorate, Egypt in 2003 and 2004 seasons. Results showed that ECB larvae caused damage in both ear (shank, grain and ear top) and stalk at different levels of the plant (tassel, tassel + one leaf, tassel + two leaves, tassel + three leaves and at ear level). The total percent of infested plants with ECB were 29.2% (10.5 stalks + 18.7 ears) and 28.6% (10.3 stalks + 18.3 ears) in 2003 and 2004 seasons, respectively.

Based on the data obtained from simulated and natural infestation using a given equation, yield loss could be estimated by field survey of the number of stems broken at different plant levels. The actual loss in grain yield was 0.38 and 0.31 kg/100 plants in 2003 and 2004 seasons, respectively, compared to 0.35 and 0.29 kg/100 plants estimated by the given equation. The differences between the actual and estimated loss in yield is not considerable. This finding ascertains that the use of such equation facilitate the assessment of ECB damage to maize plants through field observation of infestation symptoms as broken stems only.

INTRODUCTION

The European corn borer (ECB) *Ostrinia nubilalis* (Lepidoptera: Pyralidae) is a major economic pest of corn (*Zea mays*), and considered one of the most damaging borers of maize in Egypt. The larvae of ECB cause direct losses by boring into plant stems or ears in addition to indirect losses by facilitating the infection by micro-organisms.

ECB larvae act as vectors of Fusarium, causing kernel rot (Sobek and Munkvold, 1999). In Germany, the yield losses due to ECB in testcross hybrids amounted to 40% (Kreps et al, 1998). In Egypt, Semeada (1998) found that 13-18% reduction in yield of maize was due to *O. nubilalis*. Bohn et al, 1999, found that ECB infestation reduced average maize grain yield of the hybrids by 0.28% for each 1% of damaged plants and by 6.05% for each European corn borer larvae per plant. Also, Szoke et al (2002) found that losses caused by this pest ranged from 250-1000 kg/ha.

The aim of the present work is to estimate the effect of natural as well as simulated infestation of *O. nubilalis* at different plant parts (stems and ears) on yield losses of maize to set up a simple equation facilitates the estimation of yield loss in

the field without dissecting the plants.

MATERIALS AND METHODS

Two kinds of experiments were done in the present work; the first was for monitoring the infestation with *O. nubilalis* through the season and the second was for assessment the damage in maize yield through natural or simulated infestation.

1- Monitoring the infestation and natural damage:

The experiments were carried out during 2003 and 2004 seasons in Fayoum Governorate. The experimental area was divided into four equal plots; each contained 40 rows 6 m long and 70 cm wide. Maize seeds (Balady variety) were planted at the 2nd week of May in both seasons and the experimental area received all normal agricultural practices with no insecticides.

To monitor the ECB infestation, 25 stand plants (6 weeks after planting) were randomly chosen from each plot and examined to record the types of infestation as breaking or drying maize stalks.

At harvest in the end of August, 1000 plants (250 /plot) were randomly chosen, dissected and examined to confirm the previous symptoms of infestation and to determine the percent of each symptom. Also, 300 ears were randomly gathered and examined to record number of damaged grains per ear to assess grain yield loss.

2- Simulation damage:

An experiment, similar to that mentioned before, was carried out at the same seasons and region. The experimental area was periodically sprayed with a suitable recommended insecticide when it was necessary to minimize the natural insect infestation.

Eight weeks after plantation, damage of *O. nubilalis* was simulated through five different treatments, in addition to the control (healthy plants), by cutting the stem at the: tassel, tassel + one leaf, tassel + two leaves, tassel + three leaves and at ear level. The experimental area was divided into four equal plots; each contained 36 rows 6 m long and 70 cm wide (each treatment 6 rows).

At harvest, 200 ears/treatment or control (50 /plot) were randomly collected and left for one month to dry. Weight of ears and cobs were then obtained to determine the weight of grains/ear. The obtained data was computed to set up the following new equation (no.2) which can be applied to estimate the loss in the grain due to ECB infestation:

$$L = Y \times M \text{ (with ears infestation).....(1)}$$

Where L = Loss in weight due to infested grains
Y = number of damaged grains
M = mean weight of healthy grain.

$$L = X (n r + n_1 r_1 + n_2 r_2 + n_3 r_3 + n_4 r_4)/100 \text{ (with stalks infestation).....(2)}$$

Where L = Yield loss
X = mean weight of grain per healthy ear
n = number of broken tassels
n₁ = number of broken plants at the tassel + 1 leaf
n₂ = number of broken plants at the tassel + 2 leaves
n₃ = number of broken plants at the tassel + 3 leaves
n₄ = number of broken plants at ear level

r & r_1 & r_2 & r_3 & r_4 = % grain weight reduction for each type of damage comparing with undamaged plants

RESULTS AND DISCUSSION

1- Natural infestation:

Results in table (1) revealed that, damage of *O. nubilalis* began to appear on stalks 7 weeks after planting date. This agreed with Abed-Elgayed (1996) who found that *O. nubilalis* infestation started 4 to 7 weeks after planting according to sowing date.

The insect induce five sorts of damage according to the situation of infestation as drying or breaking of: the tassel, tassel + 1 leaf, tassel + 2 leaves, tassel + 3 leaves and at ear level, other down parts were not damaged. The percents of final damaged plants with the previous infestation sorts were 1.9, 1.8, 1.9, 3.0 and 1.0 % in 2003 season and 2.9, 3.0, 2.4, 0.9 and 0.6 % in 2004 season, respectively, with a total percent ranged between 9.5 and 9.8%.

Also results presented in Table (2) confirmed that, *O. nubilalis* nearly infests only the upper half level of maize stalks. The total percentages of damaged plants were 10.5 and 10.7% in 2003 and 2004 seasons, respectively. The level of tassel + 1 leaf received the highest percentage of damage (34.3&41.1) followed by tassel (21.9&30.8), tassel + 2 leaves (18.1&14.0), tassel + 3 leaves (17.1&8.4). Ear level had the lowest percentages of damage (8.6&5.6) in 2003 and 2004 seasons, respectively. Calvin *et al.* (1988) reported that, the average probability of larval occurrence per stratum was 18.4, 59.5 and 22.1% for the bottom, middle and top strata, respectively. The same author found that, there was no relationship between grain yield and level of infestation in the top stratum regardless of the plant stage. In Egypt, El-Naggar (1997) found that different larval instars of *O. nubilalis* infest maize stalk with high percentage while other plant parts were less infested. In Slovakia, Cagan (1998) reported that the first damage of ECB occurs in upper internodes of maize plants and internodes 7-9 had the highest amount of larval entrance holes.

Data presented in (Table 3) showed that the ECB larvae attack the ear through the top, husks or the shank to feed on grains and cob. In general, the percentages of infested ears were 18.7 and 18.3 in 2003 and 2004 seasons, respectively. The highest infestation percent (10.0) in the first season was for ear top, while the grains received intermediate percent (5.0%) and ear shanks received the lowest infestation (3.7%). In the second season the grains had the highest infestation (11.0%), followed by ear tops (6.0%), and shanks (1.33%). In this respect, El-Naggar (1997) in Egypt, found that, the average percentage of infested ears was 15.7%. Also, in USA, Andreadis (1988) recorded 37.0 and 19.0% damaged ears by ECB in June and July plantations, respectively. Most of damage basically occurs to the grains due to larval feeding, and secondary to the infection with rot pathogens. In this respect Ivashchenko (1996) mentioned that, the effect of infestation by the insect includes hidden damage due to larval penetration through the top or pedicle of the ear resulting in rotting of the cob and grains.

2- Natural infestation and yield loss:

The total numbers of damaged grains per 100 ears due to ECB larval feeding were 513 and 425 grains and the corresponding losses in their weights were 163.95 and 137.62 gm. in 2003 and 2004 seasons, respectively. Mean weights of 100 grains were 31.96 and 32.38 gm. in both respective seasons. Percent reduction in the grain

weight of 100 ears was 1.60 in the first season and 1.37% in the second one, Table (4).

3- Simulated damage and grain yield:

Data presented in Table (5) showed that simulated *O. nubilalis* damage reduced grains yield with about 4.11- 35.14% according to the sort of damage. Mean weights of grains were 9.724, 9.066, 7.733, 7.467 and 6.577 gm/100 ears for the different sorts, respectively and 10.141gm/100 ears for the control. The corresponding percents of yield reduction were 4.11, 10.61, 23.74, 26.37 and 35.14%, respectively. Such data could be used in the equation no.2 to determine the loss in grain yield due to the simulated (or natural) damage caused by ECB.

Applying the fore mentioned equations (1 and 2), yield losses were (0.188 + 0.164) and (0.147 + 0.138) kg/100 plants in 2003 and 2004 plantations, respectively. Therefore, the total losses were 0.352 and 0.285 kg/100 plants. The actual losses in the same seasons were 0.380 and 0.310 kg/100 plants. Thus the actual loss in yield was not considerably different from those estimated using the equations. Also the total percents of infested plants with ECB were 29.2 (10.5 stalks + 18.7 ears) and 28.6 (10.3 stalks + 18.3 ears) in 2003 and 2004 seasons, respectively. This finding ascertains that the use of such equation facilitates the assessment of *O. nubilalis* damage to maize plants through field observation of symptoms only. In this respect Szoke *et al.* 2002, mentioned that, losses caused by ECB ranged 250-1000 kg/ha, depending on the degree of infestation, year, and yield averages.

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Table 1. Monitoring natural infestation sorts with *O. nubilalis* and maize yield in 2003 and 2004 seasons at Fayoum.

Inspection date	Infestation %					Total	Yield (Kg) /100 ears	
	Tassel	T+1 leaf	T+2 leaves	T+3 leaves	At ear level		treatment	control
2003								
1/6	0.0	0.0	0.0	0.0	0.0	0.0	9.89	10.27
28/6	0.62	0.25	0.0	0.0	0.0	0.87		
5/7	1.12	0.87	0.75	1.25	0.25	4.25		
12/7	1.25	1.12	1.0	1.75	0.25	5.37		
19/7	1.25	1.37	1.37	2.5	0.37	6.87		
26/7	1.62	1.5	1.75	2.75	0.75	8.37		
2/8	1.87	1.75	1.87	3.0	0.1	9.5		
9/8	1.87	1.75	1.87	3.0	1.0	9.5		
16/8	1.87	1.75	1.87	3.0	1.0	9.5		
2004								
25/6	0.0	0.0	0.0	0.0	0.0	0.0	9.7	10.01
2/7	0.5	0.12	0.37	0.0	0.0	0.5		
9/7	0.62	0.87	1.62	0.62	0.0	3.75		
16/7	2.0	2.62	1.87	0.62	0.0	7.12		
23/7	2.87	2.87	2.0	0.87	0.12	8.75		
30/7	2.87	3.0	2.12	0.87	0.62	9.5		
6/8	2.87	3.0	2.37	0.87	0.62	9.75		
13/8	2.87	3.0	2.37	0.87	0.62	9.75		
20/8	2.87	3.0	2.37	0.87	0.62	9.75		

Table 2. Comparative percentages of *O. nubilalis* damage with the different infestation sorts at harvest in 2003 and 2004 seasons.

Season	Infestation sorts/1000 plant					Total	
	Tassel	T+1 leaf	T+2 leaves	T+3 leaves	At ear level		
2003	No.	23	36	19	18	9	105
	%*	21.9	34.3	18.1	17.1	8.6	10.5
2004	No.	33	44	15	9	6	107
	%*	30.8	41.1	14.0	8.4	5.6	10.7

* Comparing with total infested stems.

Table 3. Effect of ECB damage on different parts of corn ears in 2003 and 2004 seasons.

Season	Infested ears %			Total
	Shank	Husk (grains)	Ear top	
2003	3.67	5.0	10.0	18.7
2004	1.33	11.0	6.0	18.3

Table 4. Effect of ECB damage on maize grain yield in 2003 and 2004 seasons.

Season	No. of damaged grains/100 ears	Mean weight (gm) of 100 healthy grains	Loss in grains (gm.)/100 ears	Mean weight (Kg) of 100 healthy ears	% reduction of grain yield
2003	513	31.96	163.95	10.27	1.60
2004	425	32.38	137.62	10.01	1.37

Table 5. *O. nubilalis* damage simulation and grain yield during 2003 and 2004 seasons.

Sorts of simulated damage	Weight of grain /100 ears (kg.)			Average reduction (%)
	2003	2004	Mean	
Tassel	9.665	9.783	9.724	4.11
Tassel + 1 leaf	9.100	9.032	9.066	10.61
Tassel + 2 leaves	7.976	7.490	7.733	23.74
Tassel + 3 leaves	7.535	7.400	7.467	26.37
Ear level	6.872	6.283	6.577	35.14
Control	10.271	10.012	10.141	-

تقدير الفقد في محصول الذرة الشامية الناتج عن الإصابة بدودة الذرة الأوروبية *Ostrinia nubilalis* Hub.

إبراهيم مخيمر صيرة ، محمود محمد إبراهيم خيوة ، محمد سيد إبراهيم شلبي

معهد بحوث وقاية النباتات ، مركز البحوث الزراعية ، الدقي.

أجريت هذه الدراسة بمحافظة الفيوم خلال عروات موسمي ٢٠٠٣ / ٢٠٠٤ وذلك لتسجيل مظاهر الإصابة وتقدير الفقد في محصول الذرة الشامية الناتج عن الإصابة الطبيعية بدودة الذرة الأوروبية *O. nubilalis* أو محاكاتها واستخدمت النتائج المتحصل عليها في الحالتين في معادلة لتقدير الفقد في المحصول عن طريق عد السيقان المكسورة أو الجافة عند مستويات مختلفة من النبات (كبدل عن طريقة تشريح النباتات) مع اخذ وزن المحصول الناتج من النباتات السليمة والمصابة في الاعتبار والمعادلتين هما:

$$\text{الفقد في المحصول نتيجة إصابة الساق} = (ن_1 + ن_2 + ن_3 + ن_4 + ن_5 + ن_6 + ن_7 + ن_8 + ن_9 + ن_{10}) \times 100 \dots (1)$$

حيث و = متوسط وزن الحبوب للكورز السليم

ن = عدد النباتات المكسورة النورة المذكرة

ن_١ = عدد النباتات المكسورة أسفل النورة المذكرة + ورقة واحدة

ن_٢ = عدد النباتات المكسورة أسفل النورة المذكرة + ورقتين

ن_٣ = عدد النباتات المكسورة أسفل النورة المذكرة + ثلاث ورقات

ن_٤ = عدد النباتات المكسورة عند مستوى الكورز

س_١ ، س_٢ ، س_٣ ، س_٤ = النسبة المئوية للخفض في المحصول (وزن الحبوب) لكل من أعراض الضرر السابقة على الترتيب.

$$\text{الفقد في المحصول نتيجة إصابة الكورز} = \text{عدد الحبوب المفقودة} \times \text{متوسط وزن الحبة السليمة} \dots (2)$$

أوضحت النتائج أن الفقد في المحصول المقدر تقليدياً (بوزن المحصول) لموسمي ٢٠٠٣ و ٢٠٠٤ هو ٠,٣٨ ، ٠,٣١ كجم/١٠٠ نبات على الترتيب. وكان الفقد في المحصول المقدر بتطبيق المعادلة لنفس الموسمين هو ٠,٣٥ (٠,١٨٨ + ٠,١٦٤) و ٠,٢٩ (٠,١٤٧ + ٠,١٣٨) كجم/١٠٠ نبات على الترتيب. ومن الواضح أن الفرق بين كلتا الطريقتين غير معنوي أي انه يمكن الاعتماد على استخدام هذه المعادلة لتقدير الفقد في محصول الذرة الشامية حقلياً بعد حصر النباتات التي تظهر عليها أعراض الإصابة (المكسورة) في مستوياتها المختلفة بدلا من الطريقة التقليدية بتشريح النباتات

وتسجيل تعداد اليرقات والثقوب مما يوفر كثيرا من الوقت والجهد. كذلك أظهرت النتائج أن نسبة الإصابة الكلية ٢٩,٢% (١٠,٥ سيقان + ١٨,٧ كيزان) و ٢٨,٦% (١٠,٣ + ١٨,٣) في موسم ٢٠٠٣ و ٢٠٠٤ على الترتيب.